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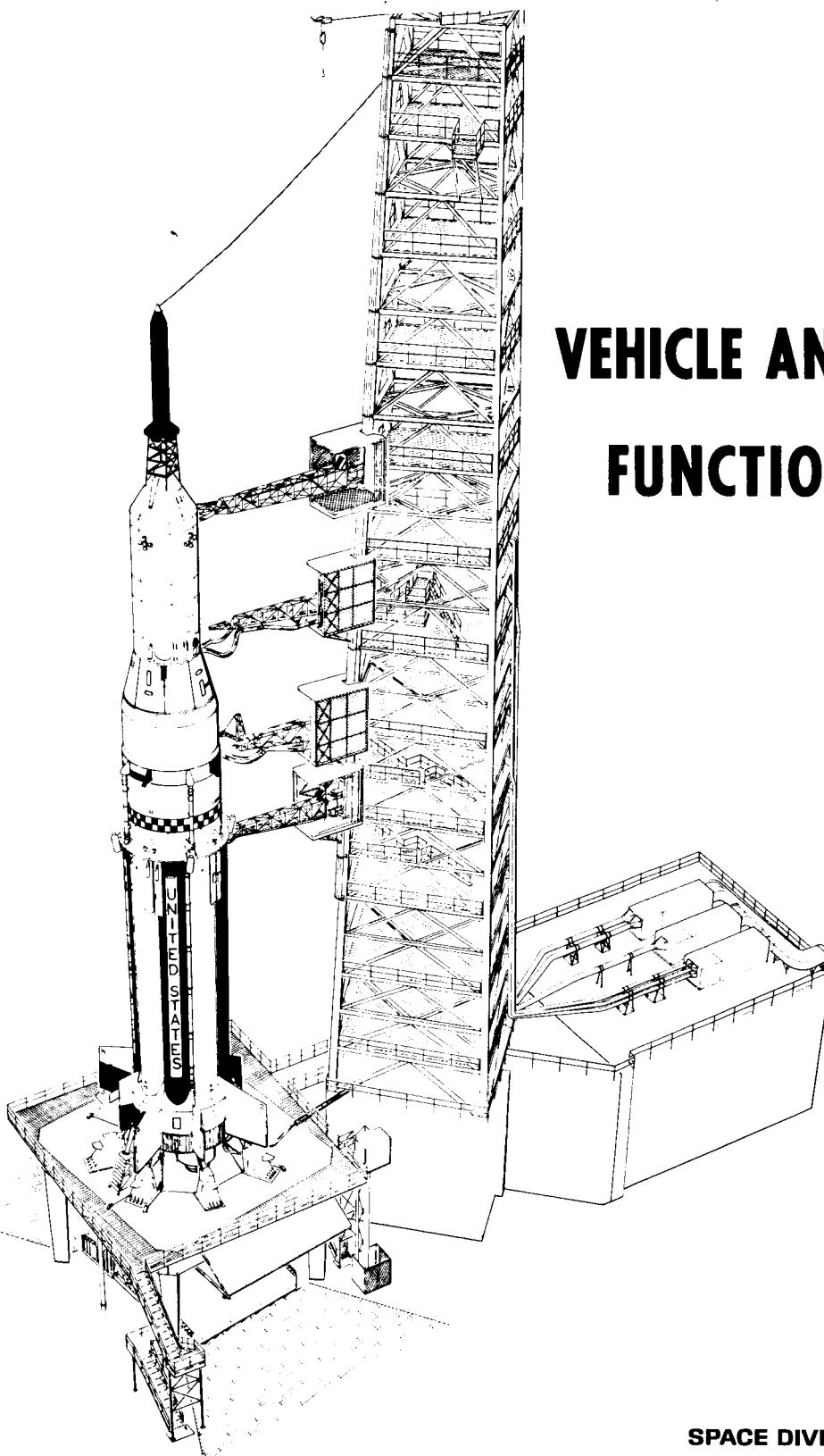
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SA-7

# VEHICLE AND LAUNCH COMPLEX FUNCTIONAL DESCRIPTION

## LOX SYSTEM



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VEHICLE AND LAUNCH COMPLEX  
FUNCTIONAL DESCRIPTION

LOX SYSTEM

APRIL 1964

ENGINEERING COMMUNICATIONS DEPARTMENT



HUNTSVILLE OPERATIONS

## FOREWORD

This volume has been prepared for the Functional Integration Section, Systems Integration and Operations Branch, Vehicle Systems Division, Propulsion and Vehicle Engineering Laboratory, by the Engineering Communications Department, Chrysler Corporation Space Division, under contract number NAS8-4016.

The following series, of which this volume is a part, functionally describes the mechanical and electromechanical systems of Saturn I, SA-7 space vehicle and Launch Complex 37:

- Volume I. RP-1 Fuel System
- Volume II. LOX System
- Volume III. LH<sub>2</sub> System
- Volume IV. Nitrogen and Helium Storage Facility
- Volume V. Pneumatic Distribution System
- Volume VI. Environmental Control System
- Volume VII. Launch Pad Accessories
- Volume VIII. H-1 Engine and Hydraulic System
- Volume IX. RL10A-3 Engine and Hydraulic System
- Volume X. Separation and Flight Termination Systems
- Volume XI. Supplement: Legend and Composite Schematic

Each volume contains mechanical schematics and a list of applicable finding numbers.

Volume II describes those components that are active during countdown, launch, and flight: it specifically excludes maintenance procedures. Only information available by December 5, 1963, has been included.

## TABLE OF CONTENTS

	Page
1. DESCRIPTION . . . . .	1
1.1. Storage Facility . . . . .	1
1.2. Launch Control Center (LCC) . . . . .	2
1.3. Launch Pad B . . . . .	2
1.4. S-I Stage . . . . .	3
1.5. S-IV Stage . . . . .	3
2. OPERATION . . . . .	4
2.1. Storage Facility . . . . .	4
2.2. Storage Facility, Launcher, LOX Pit and S-I Stage . . . . .	7
2.3. Launcher, LOX Pit and S-I Stage . . . . .	10
2.4. Storage Facility, S-IV Tower Complex, and S-IV Stage . . . . .	11
2.5. S-IV Tower Complex and S-IV Stage . . . . .	13
2.6. Flight . . . . .	14
LIST OF FINDING NUMBERS . . . . .	17
MECHANICAL SCHEMATICS . . . . .	59
DISTRIBUTION . . . . .	65

## 1. DESCRIPTION

The Launch Complex 37 LOX system fills, replenishes, drains, and pressurizes the Saturn I Vehicle LOX containers.

The LC 37 LOX system consists of a LOX storage facility and related LOX loading equipment, located on Launch Pad B and in the launch control center (LCC).

Two independent vehicle LOX systems store and supply LOX for S-I and S-IV stage engine operation.

The S-I and S-IV stage LOX systems consist of storage containers, container pressurization systems, and suction lines that supply LOX to the H-1 and RL10A-3 Engines (Vol. VIII and IX).

Automatic or semiautomatic LOX transfer, automatic monitoring, semi-automatic prelaunch simulation, and manual checkout make up the various phases of LOX system operation. LOX transfer to the vehicle proceeds through a coordinated sequence whereby elements of S-I and S-IV filling occur simultaneously. Fill, drain, and replenish lines precool operations reduce line temperatures to minimize gaseous oxygen (GOX) buildups that could cause line rupture and/or improper LOX flow.

Replenish operations which compensate for boiloff losses begin approximately 2 hours before ignition and terminate at initiation of the automatic sequence. Drain operations provide LOX return to the storage facility at the conclusion of checkout or abort procedures.

The LCC houses master controls for the LOX loading systems within LC 37. S-IV LOX loading functions through the S-IV propellant utilization (PU) system, while S-I LOX loading control comes from the LOX tanking computer in the automatic ground control station (AGCS) Pad B, and the LOX control panel in the LCC.

### 1.1. Storage Facility

A main storage tank, a replenish tank, two vaporization systems, main and replenish tank sensing cabinets, a pneumatic control console, transfer lines, pumps, blowers, various valves, and associated hardware make up the LC 37 LOX storage facility.

The main storage tank holds 125,000 gallons of LOX with a 12 percent ullage. The spherical, dual-walled tank is mounted on six columns. The inner sphere, in which the LOX is stored, is 33 ft 3 in. I.D. and is made of 5083-0 aluminum. The outer sphere is of low carbon steel, A283 grade C. The 4½ feet of annular space between the walls is filled with perlite insulation.

The dual-walled, cylindrical replenish tank is mounted horizontally on the LOX pad and stores 28,000 gallons of LOX with a 5 percent ullage. The inner tank is constructed of 5083-H13 aluminum, while the outer shell is low carbon steel. The one foot of annular space between the walls is filled with perlite insulation.

A vaporization system for each tank converts LOX to GOX for tank ullage pressurization. These systems become operative only when LOX loading begins. The main and replenish tank sensing panels house controls and monitoring devices for checking tank LOX levels, and inner wall pressure and vacuum; for operating the tank pressurization systems; and for monitoring booster and upper stage pump discharge pressures.

The pneumatic control console provides GN<sub>2</sub> control pressure for pneumatic valve and controller actuation and purge flow.

### 1.2. Launch Control Center

Propellant loading racks numbers 3, 4, and 5 in the LCC house equipment for master control of LOX loading operations. This equipment initiates, controls, corrects, and monitors LOX transfer operations, provides LOX transfer system component manual checkout and simulates LOX transfer. Rack number 3 houses a computer readout distributor, sequence recorder, propellant monitor, computer distributor, and a relay distributor. Rack number 5 houses a LOX supply monitor, digital indicator, LOX computer, and a relay distributor. Rack number 4 houses the auxiliary components panel, LOX DC power panel, LOX components panel, LOX control panel, and a relay distributor.

### 1.3. Launch Pad B

Pad B LOX loading equipment is located in the AGCS, the S-IV tower complex (S-IV TC), the launcher, and the LOX pit. The following subparagraphs describe this equipment in each of these areas.

1.3.1. Automatic Ground Control Station. LOX loading equipment on the AGCS second floor consists of panels mounted in the propellant level control system data transmission rack, the propellant level control system calibration and monitor rack, and the launcher accessories rack number 2. The LOX loading computer, mounted in the calibration and monitor rack, senses differential pressure ( $\Delta P$ ) through sensing lines brought in from the vehicle and generates an electrical analog of the  $\Delta P$ . Switching points for 75 percent full and stop-fast-fill are generated by the computer and monitored by the LOX computer panel in the LCC.

1.3.2. S-IV Tower Complex (S-IV TC). LOX loading equipment located in the S-IV TC consists of the main fill and topping control valve complex, the S-IV fill, replenish and drain line, the S-I and S-IV main fill and replenish precool valves, and associated solenoid control valves and plumbing. The major portion of this equipment is located at the umbilical tower 108-ft level. The main fill and topping control valve complex mounts on a sled and is installed as a unit on the tower. The sled has two runners with cross pieces

that support the valves, a transducer box, and a junction box. The S-IV fill, drain, and replenish line connects the valve complex to the S-IV stage umbilical housing through swing arm number two. Two other LOX transfer lines connect to the valve complex, one from the S-I replenish line and the other from the storage facility.

1.3.3. Launcher and LOX Pit. LOX loading equipment on the launcher consists of the LOX mast which connects the S-I main fill and drain line to the S-I stage fill and drain nozzle. The LOX bottom and top computer sensing lines and couplings connect to the vehicle fin IV umbilical housing through short cable mast number four. The LOX replenishing coupling half, bracket mounted on the launcher, connects to the vehicle replenish coupling-half at fin position IV. The main fill and replenish solenoid control valves, lines, and coupling-halves connect to the fin IV umbilical housing through short cable mast number four. The LOX container prepressurization solenoid control valves, orifices, coupling-half, and lines connect to the fin II umbilical housing through short cable mast number two. The LOX bubbling solenoid control valve, the line, and the coupling-half connect to the vehicle fin IV umbilical housing through short cable mast number four. LOX loading equipment located in the LOX pit near the launcher consists of the computer controlled pneumatic relay, the replenish throttle control valve, the replenish control solenoid, S-I throttle bypass valve, the replenish line drain valve, the S-I mast drain valve and the S-I main fill valve.

#### 1.4. S-I Stage

Five containers supply LOX to the S-I stage H-1 engines during S-I stage powered flight. Four 70 in. diameter containers (0-1, 0-2, 0-3, and 0-4) surround the central 105 in. diameter container (0-C). The four outer containers are mounted alternately between pairs of fuel containers so that each container feeds one inboard and one outboard engine. Each outer container measures 677 in. long with an approximate capacity of 11,000 gallons, including ullage. Four interconnect lines join the four outer container sumps to the center container sump, allowing LOX container fill through a common coupling for fill and a common coupling for replenish. Four GOX interconnect lines join the outer container ullage to the GOX pressurization manifold, which is bolted to the center container forward bulkhead. The manifold provides equal ullage GOX pressure distribution to all five containers.

Two vent and relief valves and one vent valve provide overpressurization protection for the LOX containers. LOX converted to GOX pressurizes the LOX containers during flight, while He prepressurizes the containers until main-stage operation commences.

Eight LOX suction lines, with flexible bellows joints, supply LOX to the engines through prevalues that are held open by GN<sub>2</sub> control pressure.

#### 1.5. S-IV Stage

The S-IV LOX system stores and supplies pressurized LOX to the six RL10A-3 engines during S-IV powered flight. The system consists of a 1262-cu

ft container, six thermally insulated suction lines with flexible bellows joints, a capacitance-type LOX level sensor, a cold He system which supplies high pressure He for container pressurization, a LOX bubbling system, and associated valves, switches, orifices, and plumbing.

The S-IV umbilical plate provides all necessary connections to GSE through swing arm number two for S-IV LOX system operation prior to liftoff.

## 2. OPERATION

Components required for various sequential operations are grouped under this subsection according to location.

The storage facility, launcher, LOX pit, S-IV tower complex, S-I stage, and S-IV stage comprise the locational areas. Sequences leading to vehicle launch are grouped under the area or areas which contain the components utilized in each sequence. During flight, only those components required for vehicle operation are discussed in this section.

### 2.1. Storage Facility

Equipment necessary to receive, store, and transfer LOX to and from the launch pad is located in the storage facility.

2.1.1. Pneumatic Control Console (PCC). The PCC receives 3500-psig GN<sub>2</sub> from the high-pressure GN<sub>2</sub> and He storage facility and drops the pressure in increments to 750, 120, 50, and 25 psig (figure 2). Pneumatic Filter A2707 removes contaminants from the GN<sub>2</sub>, thereby providing regulator contamination protection. Orifice A2734 reduces 3500 psig to 50 psig; Regulator A2704 reduces 3500 psig to 750 psig; Regulator A2705 reduces 750 psig to 120 psig; and Regulator A2706 reduces 120 psig to 25 psig. Three ports supply GN<sub>2</sub>; one at 750, one at 50, and one at 25 psig.

Manual Valves A2712, A2713, A2714, A2720, A2726, and A2715 allow isolation of various segments of the system. Manual Valves A2718, A2721, A2723, A2724, A2722, A2719, A2717, A2730, and A2716 provide complete system manual venting.

Pressure Gages A2700, A2701, A2702, and A2703, provide visual pressure indications within each system leg. Relief Valves A2708, A2709, A2710, and A2735 provide automatic individual leg relief at 900, 120, 35, and 55 psig, respectively.

Manual Valve A2771 can be closed to isolate the entire console when replacement, repair, or shutoff of flow to the console is desired. Pressure Switches A2725 and A2711 send pressure OK signals to indicator lights on a panel in the LCC when the desired pressure is reached in the 750- and 25-psig legs.

2.1.2. Main Tank Fill. LOX, transported to Complex 37 in trailers, is pumped into the Main Storage Tank A300 through hoses which couple to the main Tank fill coupling-half assemblies (see figure 3).

LOX passes from the trailers through Coupling-Half Assemblies A108, A109, A120, A121, and A122, through Manual Valves A91, A67, A116, A117, and A118, past Relief Valve A80, which relieves at 75 psig, through Strainer A126 and Manual Valve A308, into the Main Tank A300. When the LOX reaches the desired level, it flows through the open Trycock Valve A311. Valve A311 now closes and LOX tank fill terminates. Manual Valve A316 opening allows the Tank A300 LOX level to be read on Differential Pressure Gage A312. The main tank inlet and outlet lines drain through Manual Valves A127, A128, A129, A130, A113, A68, A70, A71, A112, and A131 into a common line and through Check Valve A114.

2.1.3. Main Tank Annular Space Pressurization. The annular space between the Main Tank A300 walls receives a dry GN<sub>2</sub> pressure of 0.1 psig to prevent moisture accumulation in the perlite insulation. Two Storage Cylinder Assemblies A339 and A340 supply the GN<sub>2</sub>. One cylinder supplies GN<sub>2</sub> while the other remains on standby. When Cylinder A340 supplies GN<sub>2</sub>, Manual Valve A334 remains closed. GN<sub>2</sub> flows from Cylinder A340, by Pressure Gage A337, through Regulator A336, where the pressure drops to 50 psig, through Manual Valve A333 and Regulator A331, for another pressure reduction to 0.1 psig, and through Check Valve A332 into Tank A300 annular space. When Cylinder A340 is on standby, GN<sub>2</sub> flows from Cylinder A339, by Gage A338, through Regulator A335 and Manual Valve A334, through Regulator A331 and Check Valve A332, to Tank A300 annular space. Pressure and Vacuum Relief Valve A342 prevents structural failure of the Tank A300 walls. Compound Pressure Gage A344 monitors pressure within the double walls of Main Tank A300.

2.1.4. Main Tank Pressurization. A vaporization system, which converts LOX to GOX, pressurizes the ullage of Main Tank A300 to 30 psig. This ullage pressure minimizes boiloff losses and assists LOX flow from the Tank.

Closure of Valves A309, A307, A308, and A310 precedes main tank pressurization. DC power to Solenoid Valves A2736 and A2737 allows 750-psig GN<sub>2</sub> control pressure to close normally open Main Tank Vent Valve A1. Manual Valve A327 provides manual tank pressure relief when Valve A1 is in its normal position should Valve A1 fail to close. Power to Valves A2738 and A2739 allows control pressure opening of normally closed Main Tank Pressurization Valve A301. Manual Valve A323 opens, allowing LOX flow through open Valve A301 and Flow Control Valve A306 held in the fully open position by 25-psig GN<sub>2</sub> control pressure. From Valve A306, LOX flows through Heat Exchanger A305, where conversion to GOX commences due to ambient air being blown across the heat exchanger coils by two motor-operated fans. The GOX passes through the return line to Tank A300 ullage where the pressure starts building up. A control line leading to Controller A328 transmits ullage pressure, thus allowing 25 psig GN<sub>2</sub> Controller A328 inlet pressure to be varied proportionally from 3 to 15 psig to vary Valve A306 open position according to the ullage pressure in the Tank A300. In this way, a relatively constant ullage pressure is maintained. Should the ullage pressure exceed 30 psig, Pressure Switch A447 in the main tank sensing panel would actuate, taking power off Valves A2736 and A2737,

allowing Valve A1 to return to its normally open position, and allowing excess GOX flow through Check Valve A79 and out the vent stack.

GOX manifold A314 located in the main tank sensing panel provides a common ullage pressure source for monitoring Main Tank A300 parameters. Pressure Switch A448 sends a "pressurized complete" signal to the LOX Control panel in the LCC, when ullage pressure reaches 20 psig. Pressure Gage A313 visually indicates Tank A300 ullage pressure.  $\Delta P$  Transducer A438 signals a liquid level meter on the LOX supply monitor panel within the LCC. This meter indicates Tank A300 LOX quantity in gallons. Transducer A437 signals a pressure meter in the LOX supply monitor panel within the LCC. This meter reads ullage pressure in psig.

The vent line can be drained of foreign accumulations through Manual Valve A133. Relief Valve A317 and Burst Disc A318 mechanically protect Tank A300 from overpressurization. A line containing Manual Valve A320 allows emergency bypass of Valves A301 and A306. Relief Valve A322 relieves at 75 psig to prevent line structural failure. Valve A319 allows bypass of Valve A301, while Relief Valve A321 relieves at 75 psig to prevent LOX heat exchanger line overpressurization.

2.1.5. Replenish Tank Fill. LOX, transported to Complex 37 in trailers, is pumped into Replenish Tank A200 through hoses coupled to the replenish tank coupling-half assemblies (figure 2). LOX passes from the trailers through Coupling-Half Assemblies A123 and A124, Manual Valves A119 and A66, past Relief Valve A92 which relieves at 75 psig, through Strainer A125, Manual Valve A211 and into Tank A200. When the LOX reaches the desired level, it flows through the open Trycock Valve A230. Closure of Valve A230 terminates the replenish fill operation. Opening of Manual Valve A216 allows Tank A200 LOX level to be read on Differential Pressure Gage A212. Replenish Tank A200 fill lines drain through Manual Valves A132 and A69 into a common line and through Check Valve A28.

2.1.6. Replenish Tank Annular Space Evacuation. A portable vacuum pump connected through Manual Valve A228, vacuum line and Filter A229 creates a 20 micron vacuum within the perlite insulated Tank A200 walls. Vacuum within the walls is measured through the line containing Manual Valves A218 and A219, and by Vacuum Gage A217 which provides a visual indication of annular space vacuum. Relief Valve A237 relieves any pressure buildup within the walls at 2.3 psig.

2.1.7. Replenish Tank Pressurization. A vaporization system that converts LOX to GOX pressurizes the ullage of Replenish Tank A200 to 195 psig. This ullage pressure minimizes LOX boiloff losses and force feeds the LOX to the vehicle containers during replenish operations. Closure of Valves A210 and A211 precedes Tank A200 pressurization. DC power on Solenoid Valves A2752 and A2753 allows 750-psig GN<sub>2</sub> control pressure to close normally open Replenish Tank Vent Valve A4. Manual Valve A220 provides Manual Tank A200 pressure relief when Valve A4 is in its normal position or fails to close. Power on Valves A2754 and A2755 allows control pressure opening of normally closed Replenish Tank Pressurization Valve A201. Manual Valve A227 opens allowing

LOX flow through open Valve A201 and Flow Control Valve A206, held in the fully open position by 25-psig GN<sub>2</sub> control pressure. From Valve A206, LOX flows through Heat Exchanger A205<sup>2</sup> where conversion to GOX commences due to ambient air being blown across the Heat Exchanger A205 coils by two motor-operated fans. The GOX passes through the return line to Tank A200 ullage where the pressure starts building up. A control line leading to Controller A235 transmits ullage pressure, thus proportionally allowing 25-psig GN<sub>2</sub> Controller A235 inlet pressure to be varied from 3 to 15 psig to vary Valve A206 open position according to the ullage pressure in Tank A200. In this way a relatively constant ullage pressure is maintained. Should the ullage pressure exceed 195 psig, Pressure Switch A449 in the replenish tank sensing panel would actuate, taking power off Valves A2752 and A2753, allowing Valve A4 to return to its normally open position, and allowing excess GOX flow through Check Valve A78 and out the vent stack.

GOX Manifold A214, located in the replenish tank sensing panel, provides a common ullage pressure source for monitoring Replenish Tank A200 parameters. Pressure Switch A442 sends a "pressurize complete" signal to the LOX control panel in the LCC when ullage pressure reaches 160 psig. Pressure Gage A213 gives a visual indication of Tank A200 ullage pressure. ΔP Transducer A441 signals a liquid level meter on the LOX supply monitor panel within the LCC. This meter indicates Tank A200 quantity in gallons. Transducer A443 signals a pressure meter in the LOX supply monitor panel within the LCC. This meter reads ullage pressure in psig.

The vent line can be drained of foreign accumulations through Manual Valve A81. Relief Valve A221 and Burst Disc A222 mechanically protect Tank A200 from overpressurization. A line containing Manual Valve A224 allows emergency bypass of Valves A201 and A206. Relief Valve A226 relieves at 300 psig to prevent line structural failure. Valve A223 allows bypass of Valve A201, while Relief Valve A225 relieves at 300 psig to prevent LOX heat exchanger line overpressurization. Relief Valve A238 relieves manhole cover pressure should a leak develop between Tank A200 ullage and the hollow manhole cover.

2.1.8. Replenish Tank Refill. Should a launch delay occur, Main Tank A300 can refill Replenish Tank A200 through the Replenish Tank A200 transfer line, which contains Local Transfer Valve A231. Refill operation follows the route from the Main Tank A300 through open Manual Valve A309, past Relief Valve A90, which cracks at 75 psig to relieve GOX pressure buildup, and into the 6-inch local transfer line. DC power from a switch in the LCC auxiliary components panel actuates valves A2781 and A2782, allowing GN<sub>2</sub> control pressure opening of Valve A231. LOX flows through Valve A231 and Valve A227 into Tank A200. Replenish Tank A200 quantity meter in the LCC LOX supply monitor panel indicates when the desired Tank A200 level has been reached.

## 2.2. Storage Facility, Launcher, LOX Pit, and S-I Stage

2.2.1. Fill and Drain Lines Precool. The S-I precool operation prevents overpressurization and choking of the S-I fill line with LOX vapor and requires about 6.5 minutes. Prior to fill and drain line precool operation, DC power actuates Solenoid Valves A2748 and A2749, allowing GN<sub>2</sub> closure of S-I Line

Vent Valve A16. Power on Solenoid Valves A2766 and A2767 allows 750-psig GN<sub>2</sub> from Manual Valve A5177 in Valve Panel 10 to close S-I Mast Drain Valve A34. GN<sub>2</sub> from Valve Panel 10 also opens S-I Main Fill Valve A31 through Solenoid Valves A2764 and A2765. GN<sub>2</sub> at 750 psig from the LOX pneumatic control console opens S-I Pump Discharge Valve A7 through Valves A2746 and A2747. GN<sub>2</sub> pressure from Valve Panel 10 through Manual Valve A5177 opens Solenoid Valve A5616, and Coupling Halves A6601 and B154 open the vehicle Fill and Drain Valve B152. Precool operation begins with Manual Valve A307 opening, which allows LOX flow from Main Tank A300 through Valve A307, Strainer A99, past Relief Valve A88, which relieves line pressure at 75 psig. Manual Valve A112 remains closed during precool operation. The 30 psig GOX ullage pressure provides flow impetus. Flow continues through inoperative Transfer Pump A105, S-I Pump Discharge Valve A7, Check Valve A115, open Manual Valve A26, past line Relief Valves A110, A139, A140, and A141, which crack at 300 psig for line pressure relief. Flow continues through S-I Main Fill Valve A31, past Relief Valve A142, through Coupling Assembly A4600, Nozzle Assembly B153, Fill and Drain Valve B152, and into the O-3 sump.

2.2.2. Fill. Main fill of the S-I stage LOX containers commences approximately six hours before launch. Prior to containers fill, LOX Vent Valve B163 and LOX Vent and Relief Valve No. 1 B162-1 (pressure operated through Solenoid Valve B215) open to vent the containers during the fill operation. LOX Vent and Relief Valve No. 2 B162-2 (pressure operated through Solenoid Valve B222) opens also to vent the containers during fill. However, Valve B222 allows the vent function of Valve No. 2 B162-2 to operate only prior to launch, since a GSE signal is required to actuate Valve B222. When Valves B215 and B222 close, GN<sub>2</sub> trapped between Valves B163, B162-1, and B162-2 and Valves B215 and B222 escapes through the vent ports of Valves B215 and B222 and through Orifices B169.

At the completion of S-I precool operations, Pump A105 starts, drawing LOX from Tank A300, through Valve A307, Strainer A99, through Pump A105, and past Pressure Switch A435, which indicates "Main Fill in Operation" at the LOX control panel when pump discharge pressure reaches 160 psig. Flow continues through Valve A7, Check Valve A115, Manual Valve A26, past Relief Valves A110, A139, A140, and A141, through Valve A31, Coupling Assembly A4600, Nozzle Assembly B153, Fill and Drain Valve B152, into the O-3 sump and to the O-C sump through the sumps interconnect line. From the O-C sump, LOX flows to O-2, O-1, and O-4 through the sumps interconnect lines. The containers fill from the sumps, allowing the LOX to rise in the containers to a level based on nominal fuel density. The S-I fill and drain line empties through S-I Mast Drain Valve A34 and Check Valves A85 and A150. A GN<sub>2</sub> purge of both Pump A105 and A106 motors through Orifices A2769 and A2770 prevents motor internal explosive atmospheres and warms valve and motor components.

2.2.3. Replenish Line Precool. When the containers reach 75 percent full level during main fill, LOX Tanking Computer A83 command signal initiates the replenish line precool operation. The S-I main fill operation continues during precool. Prior to replenish line precool, the following valves actuate:

- a. Solenoid Valves A2762 and A2763 actuate, allowing GN<sub>2</sub> closing of Replenish Line Drain Valve A143.
- b. Replenish Valve B151 opens by GN<sub>2</sub> pressure from Valve Panel 10 Manual Valve A5177 through energized Solenoid Valve A5618 and Coupling Halves A6604 and B160. Solenoid Valve B216 also actuates through a GSE signal, allowing venting of GN<sub>2</sub> opening pressure through the Valve B216 vent port.
- c. Actuation of Solenoid Valves A2756 and A2757 allows GN<sub>2</sub> opening of Replenish Line Control Valve A61. Manual Valve A75 opens.
- d. Actuation of Solenoid Valves A2760 and A2761 allows GN<sub>2</sub> opening of S-I Throttle Bypass Valve A52.
- e. GN<sub>2</sub> at 25 psig from Valve Panel 5 Regulator A2109 opens Replenish and Throttle Control Valve A55 to the fully open position.
- f. Actuation of Solenoid Valves A2758 and A2759 allows Replenish Line Vent Valve A136 to close by GN<sub>2</sub> control pressure.

Pressurized LOX now flows from Replenish Tank A200 through Manual Valve A210, past Relief Valve A95, Strainer A102, Replenish Line Control Valve A61, Relief Valve A84, and through Manual Valve A75. GOX and LOX vapor relief is provided by Relief Valves A84, A87, A146 and A147. Flow continues through Valves A55 and A52, Coupling Assembly A430, Nozzle Assembly B150, and into the 0-4 sump. The replenish precool operation stops upon complete removal of LOX vapor from the S-I replenish line.

2.2.4. Replenish. LOX Tanking Computer A83 controls replenish of the S-I stage LOX containers. Computer A83, in the AGCS, generates an electrical analog of sensed differential pressure, which reaches the computer from the vehicle 0-C container through Coupling Halves B156, B157, A6605 and A6602, and a bottom and a top sensing line. During main fill and replenish operations, a purge of the bottom sensing line is maintained to keep LOX or GOX from reaching the computer. Solenoid Valve A6030 controls this purge by allowing 450-psig He to flow from Regulator A5280 in Valve Panel 10, through Orifice A6070 by Pressure Switch A6031, Orifice A6071, and Valve A6030.

The 195-psig GOX ullage pressure in Replenish Tank A200 maintains pressurized LOX flow from the tank to the vehicle. The LOX replenish flow route is identical to the replenish precool flow route (see 2.2.3). When the container LOX level passes the 100 percent mark, ΔP Switch B159 signals the LOX components panel in the LCC, which displays an overfill indication. Manual Valve B158 provides a calibration port for Switch B159. Computer A83, in conjunction with the Replenish and Throttle Control Valve A55, maintains the containers at the full level until the automatic sequence begins 150 seconds before ignition. Throttle Bypass Valve A52 remains open until the 98 percent full level is reached. The Replenish & Throttle Control Valve A55 functions similarly to Flow Control Valve A206. Solenoid Valve A2768 controls GN<sub>2</sub> flow to the controller A58. However Controller A58 functions electrically instead of pneumatically.

Upon S-I replenish termination, the S-I Stage Replenish Valve B151 closes and the Replenish Line Drain Valve A143 opens, allowing LOX drainage from the replenish line through Check Valves A96 and A150.

2.2.5. Drain. Since the S-I and S-IV drain operations function independently, either can commence at any time. A five minute S-I drain sequence timer initiates drain operation. Mast Drain Valve A34 closes, and Vehicle Vent Valve B163 and Vent and Relief Valves B162-1 and B162-2 open. The S-I Main Fill Valve A31 and the vehicle Fill and Drain Valve B152 open. Main Tank Pressurization Valve A301 closes, Replenish Tank Vent Valve A4 opens, and Replenish Tank Pressurization Valve A201 closes. Unless previously completed, the Main and Replenish Tanks A200 and A300 depressurize while the timer is counting. At the end of the five minute time delay, the S-I Line Drain Valve A19 opens through Solenoid Valves A2750 and A2751. LOX flows from the vehicle containers through the interconnect lines through Fill and Drain Valve B152, Nozzle Assembly B153, Coupling-Half A4600, Main Fill Valve A31, Manual Valve A26, Drain Valve A19, Check Valve A30, Strainer A104, Manual Valve A310, and into Tank A300. Gravity provides flow impetus toward Tank A300. Relief Valves A89 and A94 relieve any GOX pressure buildup during LOX drain operations.

### 2.3. Launcher, LOX Pit and S-I Stage

2.3.1. LOX Bubbling. Helium bubbling through the LOX suction lines prevents temperature stratification within the suction lines and containers. LOX bubbling commences upon initiation of the automatic sequence, continues for 50 seconds, and terminates prior to LOX containers prepressurization. Helium at 315 psig, from Valve Panel 10 Regulator A5245, flows through open Solenoid Valve A5607, and routes through short cable mast number four through Coupling Halves A6610 and B450 to the vehicle LOX bubbling ringline, which contains eight branch lines, one leading to each LOX suction line. From the ringline, He flows through Orifice B451 into the suction line, bubbles up through LOX Prevalve B155 into the container sump, the LOX in the container, and out LOX Vent and Relief Valves No. 1 and 2 B162-1 and B162-2 and Vent Valve B163, which remain open until container prepressurization begins. The combined flow rate of He through the LOX is approximately 560 scfm.

2.3.2. Containers Prepressurization. Helium prepressurization of the LOX containers commences 100 seconds prior to ignition. Valves B162-1, B162-2, and B163 close prior to prepressurization initiation. The containers receive pressurized He from Valve Panel 10 Manual Valve A5242 through Solenoid Valve A6029, Orifice A6069, through Coupling Halves A6508 and B385 by short cable mast number 2, through Check Valve B387 into the O-C diffuser line that leads to the O-C ullage and O-C pressurization manifold at the top of O-C.

The He pressure distributes to the other LOX container's ullage through the GOX interconnect manifold. When ullage pressure reaches 59.5 psia, Pressure Switch B167 removes power from Solenoid Valve A6029, thus stopping He flow to the vehicle. Valve A6028 remains closed at this time. Should the ullage pressure reach 65 psia, Pressure Switch B166 would signal Solenoid Valve B215 to open, allowing opening of Valves B162-1 and B163. Manual Valve B168

provides a calibration port for Switches B166 and B167. Immediately after ignition, GOX ullage pressure drops rapidly. To make up this pressure loss, both Solenoid Valves A6028 and A6029 open to allow this pressure to be made up before liftoff, through Orifices A6069 and A6068.

#### 2.4. Storage Facility, S-IV Tower Complex, and S-IV Stage

2.4.1. Fill and Drain Line Precool. Prior to precool operation, the following valves actuate:

- a. GN<sub>2</sub> pressure from Valve Panel B through energized Solenoid Valve A4006 opens LOX Main Fill Valve A4005.
- b. Solenoid Valves E319 and E320 energize, allowing He control pressure from Regulator E206 to open Fill and Drain Valve E151.
- c. LOX Container Vent Valves E153 and E154 open through Valves E212 and E214.
- d. S-IV Main Fill Precool Valve A148 opens through actuation of Solenoid Valves A4003 and A4004.
- e. Pump Discharge Valve A10 opens through actuation of Solenoid Valves A2744 and A2745.

Precool operation begins upon completion of Main and Replenish Tanks A200 and A300 pressurization. Approximately six minutes after precool flow starts, Valve A148 closes. The six-minute open period of Valve A148 allows GOX pressure buildup in the main line to vent through Check Valve A150. Precool flow follows the route from Main Tank A300, through Valve A309, past Relief Valve A90, through Strainer A100, non-operative Pump A106, Valve A10, Check Valve A45, Manual Valve A73, and past Relief Valves A44, A98, A43, and A47 that relieve at 300 psig. After Valve A148 closes, flow continues into the Main Fill and Topping Control Valve Complex A4000, through Valve A4005, Filter A4011, Valve A3151, through Coupling Assembly A3160, Nipple Assembly E150, Main Fill Valve E151, and into the LOX container E152. As redundant main LOX fill line overpressure protection, Pressure Switch A3172 opens Main Fill Precool Valve A148. Precool takes about five minutes and transfers approximately 4000 pounds of LOX to the S-IV stage.

2.4.2. Fill. Upon completion of precool operation, Valve A148 opens and the supply Pump A106 starts. Full flow to the S-IV container begins within 10 seconds after Pump A106 starts. Valve A148 starts closing 30 seconds after Pump A106 starts and reaches the fully closed position 40 seconds after Pump A106 starts, thus purging the main fill line of GOX pressure buildup for a period of 40 seconds. LOX fill flow follows the route described in paragraph 1.3.4.1. Relief Valve A90 cracks at 75 psig for main line relief while Pressure Switch A436 indicates adequate Pump A106 discharge pressure in the LCC. Relief Valves A98, A43, A44, A93, and A47 provide cumulative volume relief of excess LOX pressure in Pump A106 discharge line.

The S-IV container fills to the 98 percent level at 1000 gpm. The LOX Mass Sensor E156 signals Pump A106 shutoff at the 98 percent level by Solenoid Valves A2740 and A2741, and opens Line Vent Valve A13, allowing LOX to vent to Tank A300 through Check Valve A76. Fifteen seconds later, Valves A4005 and E151 close and umbilical Drain Valve A4023 opens by GN<sub>2</sub> through Valve A4024. LOX in the main line from the vehicle to Valve A4005 drains through Valve A4023 and Check Valve A4027. After fill to the 98 percent level terminates, Pressure Switch A3172 controls Main Precool Valve A148 as redundant overpressure protection. The S-IV stage remains on standby until the S-I stage LOX loads to the 95 percent level. Pressure Transducer A4002 monitors LOX pressure in the main fill line during the fill operation.

2.4.3. Replenish. Prior to replenish, the following valves actuate:

- a. Replenish Precool Valve A149 opens for 30 seconds through actuation of Solenoid Valves A4007 and A4008.
- b. Replenish Valve A4021 opens pneumatically through actuation of Solenoid Valve A4022.
- c. Line Vent Valve A4023 closes.

Replenish commences through Manual Valve A210, past Relief Valve A95, through Strainer A102, open Replenish Line Control Valve A61, past Relief Valve A84, through Manual Valve A75, past Relief Valves A146 and A147, past Valve A149 that closed after 30 seconds open time, through Replenish Valve A4021, past Relief Valve A4025, through Strainer A4011, Umbilical Line LOX Valve A3151, Coupling Assembly A3160, Nipple Assembly E150, Fill and Drain Valve E151, and into Vehicle Container E152. Pressure Transducer A4018 monitors replenish line pressure during the replenish operation. Replenish flow continues at 100 gpm until the S-IV propellant utilization system (PU) indicates 99.75 percent full. At this level, Replenish Valve A4021 closes and the PU system on the S-IV stage automatically signals Valve A4021 as required to maintain the S-IV LOX container level at 99.25 to 99.75 percent. Upon automatic sequence initiation, the LOX container E152 is topped to 100 percent, after which Valves E151 and A4021 close.

2.4.4. Drain. Upon 100 percent LOX Container E152 fill completion, umbilical Drain Valve A4023 opens, allowing drainage of the upstream replenish line through Check Valve A4027.

The S-IV LOX container can be drained any time in relation to draining the S-I containers. Before the S-IV LOX container can be drained, however, it must be pressurized (see 2.5.3), and Storage Tank A300 and Replenish Tank A200 must be depressurized.

The S-IV LOX container is pressurized with 43-psia He by Solenoid Valve E236 on the S-IV stage. Vent Valves E153 and E154 close. After the S-IV LOX container is pressurized, a five-minute timer starts, and Main Fill Valve A4005 and LOX Fill and Drain Valve E151 open.

The storage and replenish tanks are depressurized as follows: Vent Valve A1 and Vent Valve A4 open; Main Tank Pressurization Valve A301 and Replenish Tank Pressurization Valve A201 close; and the vaporizer fan motors stop.

After five minutes, Drain Valve A22 opens through Solenoid Valves A2742 and A2743 on signal from the timer. Pressurized LOX flows from the S-IV container through Fill and Drain Valve E151, Nipple E150, Coupling Assembly A3160, Umbilical Line LOX Valve A3151, Filter A4011, Main Fill Valve A4005, Drain Valve A22, Check Valve A30, Strainer A104, and Manual Valve A310, into Main LOX Storage Tank A300.

S-IV LOX drain terminates when Fill and Drain Valve E151, Main Fill Valve A4005 and Drain Valve A22 close.

## 2.5. S-IV Tower Complex and S-IV Stage

2.5.1. Cold Helium Fill. Three cold Helium Spheres E233, E234, and E235, mounted on the LH<sub>2</sub> container inside wall, provide He for LOX container pressurization during S-IV stage powered flight (figure 1). When the S-IV LH<sub>2</sub> fill level reaches approximately 70 percent, 3000 psig He at minus 360°F flows through Coupling Halves A3157 and E225 from a GSE He source (Vol. V). Helium flows through Check Valves E226 and E227 past Pressure Switch E245, Relief Valve E231, and Solenoid Valve E232, into Spheres E233, E234, and E235. Should a launch abort occur, Solenoid Valve E232 would dump all He in the cold helium system overboard. Relief Valve E231 relieves excessive line pressure, while Pressure Switch E245 actuates at 2940 psia indicating sufficient Sphere E233, E234, and E235 pressure to GSE.

2.5.2. LOX Bubbling. Approximately 6 minutes prior to automatic sequence initiation or 8.5 minutes before ignition, LOX bubbling commences (figure 1). Upon command, Solenoid Valve E167 opens, allowing He from GSE (Vol. V) to flow through Coupling Halves A3157 and E225, Valve E167, Filter E168, and Orifice E169 into a ringline that contains branch lines leading to each suction line. From the ringline, He flows through Check Valve E171 and Orifice E172 into the suction line. The He bubbles through the LOX in the suction line and Container E152 and out Vent Valves E153 and E154 to eliminate temperature stratification. Thermal Switch E162 actuates at minus 298°F He temperature and transmits a signal to GSE. Solenoid Dump Valve E166 establishes the cold He flow rate during LOX bubbling, allowing the cold He to pass through Orifice E163 and overboard. Pressure Switch E170 sends a pressure OK signal to GSE during LOX bubbling operation. The LOX bubbling sequence terminates when Solenoid Valve E167 closes.

2.5.3. Container Prepressurization. Prepressurization begins at the start of the automatic sequence (figure 1). The S-IV LOX Container Vent Valves E153 and E154 close through Solenoid Valves E214 and E212 de-energization. Five seconds later, Solenoid Valve E213 energizes to ensure and maintain the closure of the LOX tank vent valves. Cold He flows from Valve Panel B into the vehicle through Quick-Disconnect Coupling Halves A3157 and E225. After entering the vehicle, cold He flows through Check Valve E226, Filter E228, Solenoid Valve E236, Plenum E243, Helium Heater E241 that is not

in operation, Orifice E240, and into S-IV LOX Container E152. When the pressure in LOX Tank E152 reaches 46 psia, Pressure Switch E283 actuates and closes Solenoid Valve E236. Pressure Switch E281 actuates at 43 psia and provides a monitor for minimum liftoff pressure. Pressure Switch E280 actuates at 51 psia to provide an overpressure monitor in the LCC.

2.5.4. Purges. Just prior to the S-IV fill and drain line precool operation, Solenoid Valve A2563 in Valve Panel B actuates, allowing 50-psig  $\text{GN}_2$  to purge Umbilical Drain Line Solenoid Valve A3151 through Orifice A3171, LOX Coupling Assembly A3160 through Orifice A3170, and swing arm No. 2 umbilical housing through Orifice A3169. These purges prevent development of explosive atmospheres and reduce component freezing possibilities. The S-IV main LOX line purge commences immediately after closure of the S-IV Main Fill Valve E151.  $\text{GN}_2$  at 50 psig flows through open Solenoid Valve A2561, Filter A2562, Check Valve A3165 and into the main LOX line. This purge inerts the atmosphere within the main fill line and prevents an explosive hazard at umbilical housing disconnect after Umbilical Valve A3151 closes.

A purge of the transducer box and junction box on the Main Fill and Topping Control Complex A4000 inerts the boxes' internal atmospheres.  $\text{GN}_2$  at 750 psig from Valve Panel B, through Solenoid Valve A2546 and Filter A2547, flows past pressure OK switch A4029 through Orifice A4031 and into the explosive proof transducer and junction boxes. Relief Valves A4030 provide overpressure protection of the boxes.

## 2.6. Flight

During vehicle flight, two independent LOX systems operate to deliver LOX to the S-I and S-IV stage engines respectively. The sequences explained under the heading "Flight" cover the time period from ignition until S-IV engine cutoff.

2.6.1. S-I Containers Pressurization. LOX converted to GOX within Heat Exchangers B30 pressurizes the LOX containers during S-I powered flight. GOX flows from Heat Exchanger B30 through Check Valve B164 to a GOX manifold that collects GOX from all eight Heat Exchangers B30 and transmits it through GOX Flow Control Regulator B170, which limits flow in a GOX sensing line from the ullage area to the Regulator B170. The regulator maintains a pressure of 60 psia within the ullage of all containers through the GOX interconnect lines that connect each container ullage to the O-C ullage. Emergency Pressure Switch B166 actuates at 65 psia to open Vent and Relief Valve B162-1 and Vent Valve B163 via Solenoid Valve B215. The vent function of Vent and Relief Valve B162-2 is inoperative during flight. However, mechanical relief settings on Valves B162-1 and B162-2 provide ullage pressure relief at 55 to 62 psig.

2.6.2. S-I LOX Flow. Each S-I stage outboard LOX container supplies LOX to one inboard and one outboard H-1 engine. After ignition, LOX flows from the 0-1, 0-2, 0-3 and 0-4 sumps through Prevalves B155 that are held open by 750 psig  $\text{GN}_2$  and through open Solenoid Valve B217. After flowing through Prevalves B155, the LOX continues to the inlet side of the H-1 engine turbopumps

(Vol. VIII). During flight, the LOX level in each container closely corresponds to the level in the other four containers, since all four container sumps connect to the O-C sump through the LOX interconnect lines. Should one engine fail, the LOX in the container that would normally flow to the dead engine would be divided between the remaining seven engines. The prevalves remain open throughout S-I powered flight and close simultaneously with the firing of the engine conax valves (Vol. VIII and X). After ignition and during flight, anti-slosh baffles within each LOX container prevent LOX sloshing that might have an adverse effect on vehicle stability.

2.6.3. S-IV Container Pressurization. During S-I powered flight, the S-IV LOX container remains pressurized by Spheres E233, E234 and E235. Pressure Switch E283 signals Solenoid Valve E236 to close, should Container E152 pressure exceed 46 psia. While Solenoid Valve E236 remains open, He from Spheres E233, E234 and E235 flows through Filter E230, Regulator E229 that drops the pressure to 250 psig, Valve E236, Plenum E243 that reduces line pressure surges, non-operative He Heater E241, Orifice E240, and into Container E152 ullage. Helium also flows through open Solenoid Valve E238, Orifice E239 and through Heater E241 secondary coil.

Warm He from He Heater E241 maintains LOX container pressurization during S-IV powered flight. At a predetermined time after S-I/S-IV separation (Vol. X), the flight sequencer signals Solenoid Valve E318 to open, allowing pneumatic opening of He Heater Propellant Valves E215 and E216. LH<sub>2</sub> and LOX flow through valves E215 and E216, respectively, and into the He heater combustion chamber. Igniters E244 initiate He heater combustion, and the heater exhaust gases pass out the exhaust nozzle and through the S-IV heat shield center. The He Heater Thermal Switch E246 indicates the cold He heat exchanger Heater Assembly E241 temperature by signaling the control circuit to open or close Propellant Valves E215 and E216 through Solenoid Valves E318 and E317 according to whether the exchanger temperature is above or below 110°F. Heater E241 operates whenever the temperature is below 110°F. During heater operation, cold He flows from Spheres E233, E234, and E235 through the route described in the first part of 1.3.6.3. When the cold He enters the Heater E241 coils, it warms, expands, and flows through Orifice E240 to Container E152. Upon S-IV powered flight initiation, control of Solenoid Valve E236 switches from Pressure Switch E283 to Pressure Switch E237. When the He heater inlet line pressure increases to 320 psia, Pressure Switch E237 actuates and closes Solenoid Valve E236. When Pressure Switch E283 ceases to control Solenoid Valve E236, it begins to control Solenoid Valve E238. When the Container E152 pressure exceeds 46 psia, Pressure Switch E283 closes Solenoid Valve E238, cutting off He flow to the heater secondary coils and reducing warm He flow.

2.6.4. S-IV LOX Flow. During S-IV powered flight, LOX under an ullage pressure of 43 psia is drawn through six individual LOX suction lines to the six RL10A-3 engine mounted on the S-IV stage thrust structure (Vol. IX). The suction lines connect like wheel spokes around the LOX Container E152 base. LOX Sensor E156, a capacitor using LOX as its dielectric, signals the onboard propellant utilization system to consume nearly all LOX and reduce the weight penalty at S-IV engine cutoff to a minimum (Vol. IX and X). Should Container E152 ullage pressure exceed 50 psia during S-IV powered flight, the mechanical

relief setting on Vent and Relief Valves E153 and E154 would allow opening of Valves E153 and E154 to provide overpressure relief.

LIST OF FINDING NUMBERS

* FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A1	1	Valve, Pneumatic	Actuation 750 psig GN <sub>2</sub> 6 in., Ball-type	Hydromatics Inc. Model A132S6	10427400	
A2						
A3						
A4	1	Valve, Pneumatic	4 in.	Hydromatics Inc. Model A132P5	10427321	
A5						
A6						
A7	1	Valve, Pneuma F18	6 in. [REDACTED]	Hydromatics Inc. Model A132S5	10427325	
A8						
A9						
A10	1	Valve, Pneumatic	4 in.	Hydromatics Inc. Model A132P6	10427324	
A11						
A12						

\* Location: A = Ground; B = S-I stage; E = S-IV stage; G = Instrument Unit; H = Payload.

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A13	1	Valve, Pneumatic	4 in.	Hydromatics Inc. Model A132P5	10427321	
A14						
A15						
A16	1	Valve, Pneumatic	4 in.	Hydromatics Inc. Model A132P5	10427321	
A17						
A18						
A19	1	Valve, Pneumatic	6 in.	Hydromatics Inc. Model A132S5	10427325	
A20						
A21						
A22	1	Valve, Pneumatic	6 in.	Hydromatics Inc. Model A132S5	10427325	
A23						
A24						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A25						
A26	1	Valve, Manual	8 in.	Wm. Powell Co. PN 027209	10427454	
A27						
A28	1	Valve, Check	2 in.	Wm. Powell Co. Fig. 70-597	10427339	
A29						
A30	1	Valve, Check	6 in.	Wm. Powell Co. PN 026178	10427332	
A31	1	Valve, Pneumatic	6 in.	Hydromatics Inc. Model A132S5	10427325	
A32						
A33						
A34	1	Valve, Pneumatic	2 in.	Hydromatics Inc. Model A132K4	10427346	
A35 through A42 are not functionally applicable to this system.						
A43	1	Valve, Relief	300 psi Relief, $1\frac{1}{2}$ in.	Gardner Johnson & Co. PN 1192	10427327	

FINDING NUMBER	NO. REQ'D	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A44	1	Valve, Relief	300 psi Relief, 1½ in.	Gardner Johnson & Co. PN 1192	10427327	
A45	1	Valve, Check	4 in., 300 psig	Wm. Powell Co. PN 026178	10427322	
A46						
A47	1	Valve, Relief	300 psi Relief, 1½ in.	Gardner Johnson & Co. PN 1192	10427327	
A48						
A49						
A50						
A51						
A52	1	Valve, Pneumatic	3 in.	Hydromatics Inc. Model A132M7	10427347	
A53						
A54						
A55	1	Valve, Pneumatic	25 psig Supply Pressure 3-15 psig Signal Pressure, 2 in.	Annin Company Model 1560 W/Domotor Control	10427336	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A56						
A57						
A58	1	Controller, Pneumatic		Servomechanisms, Inc. PN 812089	10434805	53A35A3
A59						
A60						
A61	1	Valve, Pneumatic	3 in.	Hydromatics Inc. Model A132M7	10427347	
A62 through A65 are not functionally applicable to this system.						
A66	1	Valve, Manual	Shutoff 3 in.	Wm. Powell Co. PN B-50700	10427341	
A67	1	Valve, Manual	Shutoff 3 in.	Wm. Powell Co. PN B-50700	10427341	
A68	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A69	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A70	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-39844	10427342	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A71	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-39844	10427342	
A72						
A73	1	Valve, Manual	6 in.	Wm. Powell Co. PN 027209	10427453	
A74						
A75	1	Valve, Manual	3 in.	Wm. Powell Co. PN 027201	10427340	
A76	1	Valve, Check	4 in.	Wm. Powell Co. PN 026178	10427322	
A77						
A78	1	Valve, Check	4 in.	Wm. Powell Co. PN 026178	10427322	
A79	1	Valve, Check	6 in.	Wm. Powell Co. PN 026178	10427332	
A80	1	Valve, Relief	75 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427326	
A81	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A82						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A83	1	Computer, LOX Tanking			10434613	54A8A5
A84	1	Valve, Relief	300 psig Relief, 1 in.		Part of 10427331	
A85	1	Valve, Check	2 in.	Wm. Powell Co. Fig. 70-597	10427339	
A86						
A87	1	Valve, Relief	300 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427320	
A88	1	Valve, Relief	75 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427326	
A89	1	Valve, Relief	75 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427326	
A90	1	Valve, Relief	75 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427326	
A91	1	Valve, Manual	Shutoff, Gate-type, 3 in.	Wm. Powell Co. PN B-50700	10427341	
A92	1	Valve, Relief	75 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427326	
A93	1	Valve, Relief	300 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427320	
A94	1	Valve, Relief	300 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427320	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A95	1	Valve, Relief	300 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427320	
A96	1	Valve, Check	2 in., Swing-type	Wm. Powell Co. Fig. 70-597	10427339	
A97						
A98	1	Valve, Relief	300 psig Relief, 1 1/2 in.	Ladewig Valve Co. PN 11160-C	10427327	
A99	1	Strainer	2500 gpm, 8 in., 150 micron	Leslie Company	10427337	
A100	1	Strainer	1000 gpm, 6 in., 150 micron	Leslie Company	10427323	
A101						
A102	1	Strainer	500 gpm, 3 in., 150 micron	Leslie Company	10427334	
A103						
A104	1	Strainer	150 micron 6-in., $\Delta P$ 5 psig		10427323	
A105	1	Pump and Motor	Motor: 350 HP @ 3560 RPM Pump: 2500 gpm 3 PH, 60 cps, 440V	Byron-Jackson Pump Inc. MOD 6x8x11DSM(HAC)LOX	10427328	51B1
A106	1	Pump and Motor	Motor: 200 HP 1000 gpm	Byron-Jackson Pump Inc., Type SMI-LOX 4x6x12 1/2 HH	10427329	51B2

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A107						
A108	1	Coupling-Half Assembly	3 in.	Futurecraft Corp. PN 550043-30-002	10427401	
A109	1	Coupling-Half Assembly	3 in.	Futurecraft Corp. PN 550043-30-002	10427401	
A110	1	Valve, Relief	300 psig Relief, 1½ in.	Gardner Johnson & Co. PN 1192	10427327	
A111						
A112	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A113	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A114	1	Valve, Check	2 in.	Wm. Powell Co. Fig. 70-597(F.E.)	10427339	
A115	1	Valve, Check	6 in.	Wm. Powell Co. PN 026178	10427332	
A116	1	Valve, Manual	3 in.	Wm. Powell Co. PN B-50700	10427341	
A117	1	Valve, Manual	3 in.	Wm. Powell Co. PN B-50700	10427341	
A118	1	Valve, Manual	3 in.	Wm. Powell Co. PN B-50700	10427341	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A119	1	Valve, Manual	3 .	Wm. Powell Co. PN B-50700	10427341	
A120	1	Coupling-Half Assemb	✓ 3 in.	Futurecraft Corp. PN 550043-30-002	10427401	
A121	1	Coupling-Half Assembly	3 in.	Futurecraft Corp. PN 550043-30-002	10427401	
A122	1	Coupling-Half Assemb	3 in.	Futurecraft Corp. PN 550043-30-002	10427401	
A123	1	Coupling-Half Assemb	3 in.	Futurecraft Corp. PN 550043-30-002	10427401	
A124	1	Coupling-Half Assemb	3 in.	Futurecraft Corp. PN 550043-30-002	10427401	
A125	1	Strainer	500 gpm, 4 in., 150 micron	Leslie Co.	10427338	
A126	1	Strainer	1000 gpm, 6 in., 150 micron	Leslie Co.	10427323	
A127	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A128	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A129	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A130	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A131	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A132	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A133	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-49008	10427343	
A134						
A135						
A136	1	Valve, Pneumatic	1 in.	Hydromatics Inc. Model A132F1	10427345	
A137						
A138						
A139	1	Valve, Relief	300 psig Relief, $1\frac{1}{2}$ in.	Gardner Johnson & Co. PN 1192	10427327	
A140	1	Valve, Relief	300 psig Relief, $1\frac{1}{2}$ in.	Gardner Johnson & Co. PN 1192	10427327	
A141	1	Valve, Relief	300 psig Relief, $1\frac{1}{2}$ in.	Gardner Johnson & Co. PN 1192	10427327	
A142	1	Valve, Relief	300 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427320	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A143	1	Valve, Pneumatic	2 in.	Hydromatics Inc. Model A132K4	10427346	
A144						
A145						
A146	1	Valve, Relief	1 in., 300 psig		Part of 10427331	
A147	1	Valve, Relief	1 in., 300 psig		Part of 10427331	
A148	1	Valve, Pneumatic	Actuation 750 psig GN2 4 in., 300 psig		10427324	
A149	1	Valve, Pneumatic	Actuation 750 psig GN2 3 in., 300 psig	Hydromatics Inc. Model A132M7	10427347	
A150	1	Valve, Check	300 psig 4-in., Swing-type		10427322	
A151 through A199 are not functionally applicable to this system.						
A200	1	Tank, Replenish	28,000 Gallons		10427472	
A201	1	Valve, Pneumatic	3 in.	Hydromatics Inc. Model A132M7	10427347	
A202						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A203						
A204						
A205	1	Vaporizer Assembly			10427318	
A206	1	Valve, Flow Control	2 in.	The Annin Co. Model 1660	10427335	
A207						
A208						
A209						
A210	1	Valve, Manual	3 in.			Part of 10427472
A211	1	Valve, Manual	4 in.			Part of 10427472
A212	1	Gage, Liquid Level	0-29,500 Gallons	Barton Instrument Co. Model 200-D.P. Type	10427563	
A213	1	Gage, Pressure	6 in., 0-300 psig	U. S. Gauge PN 5003	10427566	
A214	1	Manifold			10427561-20	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A215						
A216	1	Valve, Manual	Shutoff ½ in.	Wm. Powell Co. PN D-39842	10427568	
A217	1	Gage, Vacuum	0-1000 Microns Hg	Consolidated Vacuum Corp., PN TG-025	10427567	
A218	1	Valve, Manual	Shutoff, 2 in.	Vacuum Research Co.	Part of 10427472	
A219	1	Valve, Manual	Shutoff		Part of 10427472	
A220	1	Valve, Manual	Shutoff, 4 in.		75M05969	
A221	1	Valve, Relief	Cracks @ 205 psig inlet 3 in. outlet 4 in.		Part of 10427472	
A222	1	Disc, Burst			Part of 10427472	
A223	1	Valve, Manual	3 in.	Wm. Powell Co. PN 027201	10427340	
A224	1	Valve, Manual	Bypass 3 in.	Wm. Powell Co. PN 027201	10427340	
A225	1	Valve, Relief	300 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427320	
A226	1	Valve, Relief	300 psig Relief, 1 in.	Ladewig Valve Co. PN 1178-C	10427320	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A227	1	Valve, Manual	6 in.		Part of 10427472	
A228	1	Valve, Manual			Part of 10427472	
A229	1	Filter			Part of 10427472	
A230	1	Valve, Manual	1 in.	Wm. Powell Co. PN D-39844	10427342	
A231	1	Valve, Pneumatic	6 in., Butterfly-type		75M06583	
A232						
A233						
A234						
A235	1	Controller, Pressure, Pneumatic	Output 3-15 psig Supply 25 psig Sensing 0-300 psig	Mason-Neillan Model 2704	10427402	
A236						
A237	1	Valve, Relief	2.3 psig Relief		Part of 10427472	
A238	1	Valve, Relief	Cracks @ 2 psig, 3/4 in.		Part of 10427472	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A239	through A299	are not functionally applicable to this system.				
A300	1	Tank, LOX Storage	125,000 Gallons		10427471	
A301	1	Valve, Pneumatic	3 in.	Hydromatics Inc. Model A132M7	10427347	
A302						
A303						
A304						
A305	1	Vaporizer Assembly			10427318	
A306	1	Valve, Flow-Control	Supply 25 psig, Positioning 3-15 psig, 2 in.	The Annin Co. PN 28265	10427335	
A307	1	Valve, Manual	Shutoff 8 in.	Wm. Powell Co. PN 027088	Part of 10427471	
A308	1	Valve, Manual	Shutoff 6 in.	Wm. Powell Co. PN B-40084	Part of 10427471	
A309	1	Valve, Manual	Shutoff 6 in.	Wm. Powell Co. PN B-40084	Part of 10427471	
A310	1	Valve, Manual	Shutoff 6 in.	Wm. Powell Co. PN B-40084	Part of 10427471	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A311	1	Valve, Gate, Manual	1 in. Trycock	Wm. Powell Co. PN D-49008	10427343	
A312	1	Gage, Liquid-Level	0-140,000 Gallons	Barton Instrument Corp. Model 200-D.P. Type	10427564	
A313	1	Gage, Pressure	0-100 psig	U.S. Gauge Co. PN 5003	10427565	
A314	1	Manifold	GOX		10427560-20	
A315						
A316	1	Valve, Manual	Shutoff $\frac{1}{2}$ in.	Wm. Powell Co. PN D-39842	10427568	
A317	1	Valve, Relief	Cracks @ 45 psig	J. E. Lonergan Co. Model 41W209M	Part of 10427471	
A318	1	Disc, Burst	Bursts at 50 psig		Part of 10427471	
A319	1	Valve, Manual	Bypass 3 in.	Wm. Powell Co. PN B-50700	10427341	
A320	1	Valve, Manual	Bypass 3 in.	Wm. Powell Co. PN B-50700	10427341	
A321	1	Valve, Relief	1 in., Cracks @ 75 psig	Gardner Johnson Co. PN 1191	10427326	
A322	1	Valve, Relief	1 in., Cracks @ 75 psig	Gardner Johnson Co. PN 1191	10427326	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A323	1	Valve, Manual	Shutoff, 4 in.		Part of 10427471	
A324						
A325						
A326						
A327	1	Valve, Manual	6 in.		Part of 10427471	
A328	1	Controller, Pressure Pneumatic	Output 3-15 psig Supply 25 psig Sensing 0-40 psig	Mason-Neilan Model 2707	10427403	
A329						
A330						
A331	1	Regulator, Manual	Inlet 50 psig, GN <sub>2</sub> Outlet 2.0 psig		Part of 10427471	
A332	1	Valve, Check	200 psig, 1-1/2 psig GN <sub>2</sub>	Wm. Powell Co.	Part of 10427471	
A333	1	Valve, Manual	Shutoff, GN <sub>2</sub>	Air Reduction Co. PN 8110	Part of 10427471	
A334	1	Valve, Manual	Shutoff, GN <sub>2</sub>	Air Reduction Co. PN 8110	Part of 10427471	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A335	1	Regulator, Preset	Inlet 2000 psig, GN <sub>2</sub> Outlet 10 psig		Part of 10427471	
A336	1	Regulator, Preset	Inlet 2000 psig, GN <sub>2</sub> Outlet 50 psig		Part of 10427471	
A337	1	Gage, Pressure			Part of 10427471	
A338	1	Gage, Pressure			Part of 10427471	
A339	1	Cylinder, Storage	GN <sub>2</sub> 222 cu. ft. @ 2000 psig		Part of 10427471	
A340	1	Cylinder, Storage	GN <sub>2</sub> 222 cu. ft. @ 2000 psig		Part of 10427471	
A341						
A342	1	Valve, Relief, Vacuum and Pressure	6 in.	Oceco Model T	Part of 10427471	
A343						
A344	1	Gage, Compound	0 to 15 psig, 0 to 30 in. Hg Vacuum	Acco Helicoid	Part of 10427471	
A345 through A429 are not functionally applicable to this system.						
A430	1	Coupling Assembly				75M03191

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A431						
A432						
A433						
A434						
A435	1	Switch, Pressure	Actuates 160 psig		10465302	51A11S1
A436	1	Switch, Pressure	Actuates 150 psig		10430024	51A11S4
A437	1	Transducer, Pressure			10465306	51A11MT1
A438	1	Transducer, Differential Pressure			10465305	51A11MT2
A439						
A440						
A441	1	Transducer, Differential Pressure	0-8 psid		10465305	51A12MT2
A442	1	Switch, Pressure	Actuates 160 psig		10430024	51A12S2

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A443	1	Transducer, Pressure	0-300 psig		10465306	51A12MT1
A444						
A445						
A446						
A447	1	Switch, Pressure	Actuates 30 psig		10465306	51A11S3
A448	1	Switch, Pressure	Actuates 20 psig		10465301	51A11S2
A449	1	Switch, Pressure	Actuates 190 psig		10465303	51A12S1
A450 through A2699 are not functionally applicable to this system.						
A2700	1	Gage, Pressure	0-10,000 psig	U. S. Gauge Co.	10437648	
A2701	1	Gage, Pressure	0-1500 psig	U. S. Gauge Co.	10437688	
A2702	1	Gage, Pressure	0-300 psig	U. S. Gauge Co.	10437687	
A2703	1	Gage, Pressure	0-60 psig	U. S. Gauge Co.	10437686	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A2704	1	Regulator, Pressure	Presets, 3000 - 750 psi, 3/8 in.	Grove Valve & Reg. Co. Model 94X	10437651	
A2705	1	Regulator, Pressure	Presets, 750 - 120 psi, 3/8 in.	Grove Valve & Reg. Co. Model 94X	10437651	
A2706	1	Regulator, Pressure	120 - 25 psig Manual	Moore Products Co. Model 42H50	10437679	
A2707	1	Filter, Pneumatic	30 micron	Permanent Filter Corp. PN 10813-10/30	10437650	
A2708	1	Valve, Relief	900 ± 50 psig Relief, 750 psig min. Reseat	Republic Mfg. Co. PN 625B-9-6	10437652	
A2709	1	Valve, Relief	120 ± 10 psig Relief, 100 psig min. Reseat	Republic Mfg. Co. PN 625B-3-6	10437680	
A2710	1	Valve, Relief	35 ± 5 psig Relief, 25 psig min. Reseat	Republic Mfg. Co. PN 625B-2-8	10437681	
A2711	1	Switch, Pressure	Actuates 21.5 ± .5 psig Deactuates 20 psig	Southwestern Ind. PN PS-3700A-4	10437682	51A2S3
A2712	1	Valve, Manual	Shutoff	Robbins Aviation PN SSNA-375A-6T	10437684	
A2713	1	Valve, Manual	Shutoff	Robbins Aviation PN SSNA-375A-6T	10437684	
A2714	1	Valve, Manual	Shutoff	Robbins Aviation PN SSNA-375A-6T	10437684	
A2715	1	Valve, Manual	Shutoff	Robbins Aviation PN SSNA-375A-6T	10437684	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A2716	1	Valve, Manual	Vent, Button-Operated Poppet	Futurecraft Corp. PN 30205	10437647	
A2717	1	Valve, Manual	Vent, Button-Operated Poppet	Futurecraft Corp. PN 30205	10437647	
A2718	1	Valve, Manual	Vent, Button-Operated Poppet	Futurecraft Corp. PN 30205	10437647	
A2719	1	Valve, Manual	Vent, Button-Operated Poppet	Futurecraft Corp. PN 30205	10437647	
A2720	1	Valve, Manual	Shutoff, Button-Operated Poppet	Robbins Aviation PN SSNA-375A-6T	10437684	
A2721	1	Valve, Manual	Vent, Button-Operated Poppet	Futurecraft Corp. PN 30205	10437647	
A2722	1	Valve, Manual	Vent, Button-Operated Poppet	Futurecraft Corp. PN 30205	10437647	
A2723	1	Valve, Manual	Vent, Button-Operated Poppet	Futurecraft Corp. PN 30205	10437647	
A2724	1	Valve, Manual	Vent, Button-Operated Poppet	Futurecraft Corp. PN 30205	10437647	
A2725	1	Switch, Pressure	Actuates 600 $\pm$ 20 psig Deactuates 550 psig	Southwestern Industries PN PS-5100A	10437683	51A2S2
A2726	1	Valve, Manual	Shutoff	Robbins Aviation PN SSNA-250-4T	10437685	
A2727						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A2728						
A2729						
A2730	1	Valve, Manual	Vent, Button-Operated Poppet	Futurecraft Corp. PN 30205	10437647	
A2731						
A2732						
A2733						
A2734	1	Orifice	0.059 in. Dia.	A.U. Stone & Co. Inc.	10430177	
A2735	1	Valve, Relief	55 + 5 psig Relief, 45 psig Min. Reseat	Republic Mfg. Co. PN 6258-3-8	10430169	
A2736	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A13
A2737	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A14
A2738	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A17
A2739	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A16

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A2740	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A31
A2741	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A32
A2742	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A35
A2743	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A34
A2744	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A29
A2745	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A28
A2746	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A19
A2747	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A20
A2748	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A22
A2749	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A23
A2750	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A26
A2751	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A25

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A2752	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A37
A2753	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A38
A2754	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A41
A2755	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A40
A2756	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A47
A2757	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A46
A2758	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A43
A2759	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	51A44
A2760	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	53A35A7
A2761	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	53A35A8
A2762	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	53A35A9
A2763	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	53A35A10

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A2764	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	53A35A16
A2765	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	53A35A15
A2766	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	53A35A12
A2767	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	53A35A13
A2768	1	Valve, Solenoid		Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	53A35A2
A2769	1	Orifice	10-12 SCFH Flowrate @ 20.7 psig	A.U. Stone Co. PN P-881-3	10428514	
A2770	1	Orifice	10-12 SCFH Flowrate @ 20.7 psig	A.U. Stone Co. PN P-881-3	10428514	
A2771	1	Valve, Manual	Shutoff, 3000 psig GN <sub>2</sub> , $\frac{1}{2}$ in.	Robbins Aviation Model SSNG 500A-8T	10428576	
A2772 through A2780 are not functionally applicable to this system.						
A2781	1	Valve, Solenoid		Marotta Valve Corp. PN 202873-113		51A49
A2782	1	Valve, Solenoid		Marotta Valve Corp. PN 202873-113		51A50
A2783 through A3150 are not functionally applicable to this system.						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A3151	1	Valve Electropneumatic	3-in., Actuation 750 $\pm$ 25 psig GN2	B. H. Hadley Inc. PN 11409-1	75M05605	57A12A21
A3152	through	A3159	are not functionally applicable to this system.			
A3160	1	Coupling Assembly			75M04852	
A3161	through	A3164	are not functionally applicable to this system.			
A3165	1	Valve, Check		Douglas Aircraft PN 3871261-501		
A3166	through	A3168	are not functionally applicable to this system.			
A3169	1	Orifice-Fitting	0.040 and 0.125 $\pm$ .010 in. I.D.		75M06686-1	
A3170	1	Orifice-Fitting	0.015 and 0.125 $\pm$ .010 in. I.D.		75M06686-2	
A3171	1	Orifice-Union	0.020 in. ID		75M06713-1	
A3172	1	Switch, Pressure	50-250 psig	Custom Components Switches Inc. PN 603G3*S MOD	75M06690	57A12A23
A3173	through	A3999	are not functionally applicable to this system.			
A4000	1	LOX Main Fill and Topping Control Assy.		Douglas Aircraft PN 7864564-501		429

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4001						
A4002	1	Transducer, Pressure	LOX, 0-150 psia	Giannini PN 4512715-15		429PT10
A4003	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	3000A1
A4004	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	3000A2
A4005	1	Valve, Pneumatic	Y-type, 4-in. 1000 gpm LOX	Pacific Valves Inc. PN 13648-EO		
A4006	1	Valve, Solenoid	4-way, 2-position Actuation 750 psig GN <sub>2</sub>	Southwestern Valve Corp. PN 804934-1-2		429NS15
A4007	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	3000A5
A4008	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 202873-113 Model MV-74	10437618	3000A4
A4009						
A4010						
A4011	1	Filter	LOX	Westward Engr & Fab. Co. PN 25041		
A4012 through A4017 are not functionally applicable to this system.						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4018	1	Transducer, Pressure	LOX, 0-150 psia	Giannini PN 4512715-15		429PT11
A4019						
A4020						
A4021	1	Valve, Pneumatic	Y-type, 2 in., 100 gpm @ 275 psia	Pacific Valves Inc. PN 13647-FO		
A4022	1	Valve, Solenoid	4-way, 2-position Actuation 750 psig GN2	Southwestern Valve Corp., PN 804934-1-2		429NS17
A4023	1	Valve, Pneumatic	Y-type, 2 in. Drain	Pacific Valves Inc. PN 13647-FO		
A4024	1	Valve, Solenoid	4-way, 2-position Actuation 750 psig GN2	Southwestern Valve Corp., PN 804934-1-2		429NS16
A4025	1	Valve, Relief		Douglas Aircraft PN 3864299-1		
A4026						
A4027	1	Valve, Check		Douglas Aircraft PN 7721093-1	LC-1	
A4028						
A4029	1	Switch, Pressure		Custom Component Switches PN 695-E-24		429PJ1

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A4030	2	Valve, Relief		James, Pond & Clark PN D559T-2M-4		
A4031	1	Restrictor		Douglas Aircraft PN DR4-0.5		
A4032 through A4599 are not functionally applicable to this system.						
A4600	1	Retractable Coupling Assembly		Flexionics Inc. PN 107435	75M00253	
A4601 through A5606 are not functionally applicable to this system.						
A5607	1	Valve, Solenoid	2-way, 2-Position 325 psig GN2	Marotta Valve Corp. PN 212783-1	10437739	53A67
A5608 through A5615 are not functionally applicable to this system.						
A5616	1	Valve, Solenoid	3-way, 2-position 750 psig GN2 actuation	Marotta Valve Corp. PN 204424	10425701	53A26
A5617						
A5618	1	Valve, Solenoid	3-way, 2-position 750 psig GN2 actuation	Marotta Valve Corp. PN 204424	10425701	53A71
A5619 through A6027 are not functionally applicable to this system.						
A6028	1	Valve, Solenoid	W/Manual Override, 2-way, 2-position	Marotta Valve Corp. PN 218914	75M02802	53A69

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A6029	1	Valve, Solenoid	W/Manual Override, 2-way, 2-position bypass	Marotta Valve Corp. PN 218914	75M02802	53A70
A6030	1	Valve, Solenoid	3-way, 2-position 750 psig GN2	Marotta Valve Corp. PN 204424	10425701	
A6031	1	Switch, Pressure	Actuates 100 psig Deactuates 50 psig	Meletron PN M7141EB-32A-2	75M50728-1	
A6032 through A6067 are not functionally applicable to this system.						
A6068	1	Orifice		A. U. Stone PN H264C-114	75M50184-2	
A6069	1	Orifice	Bypass	A. U. Stone PN H-264C-310	75M50184-3	
A6070	1	Orifice		W. O. Leonard PN 156040-5	75M50727-2	
A6071	1	Orifice		A. U. Stone PN P-881-8	75M04165-8	
A6072 through A6507 are not functionally applicable to this system.						
A6508	1	Socket, Quick- Disconnect	3000 psig	Wiggins PN 6400R107A16	75M02214	
A6509 through A6600 are not functionally applicable to this system.						
A6601	1	Socket, Quick- Disconnect	750 psig GN <sub>2</sub>	Wiggins PN 6300R109A4	75M02210	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
A6602	1	Socket, Quick-Disconnect	100 psig	Wiggins PN 6200R78A4	75M02212	
A6603						
A6604	1	Socket, Quick-Disconnect	750 psig GN <sub>2</sub>	Wiggins PN 6300R109A4	75M02210	
A6605	1	Socket, Quick-Disconnect	100 psig	Wiggins PN 6200R78A4	75M02212	
A6606	through A6609	are not functionally applicable to this system.				
A6610	1	Socket, Quick-Disconnect	1/2 in., 325 psig GN <sub>2</sub>	Wiggins PN 6200R72A8	75M02207	
A6611	through B149	are not functionally applicable to this system.				
B150	1	Coupling-Half	LOX replenishing		20M30050	
B151	1	Valve, Pneumatic	Actuation 750 psig GN <sub>2</sub> Operating 150 psig LOX	Hydromatics Inc. PN 131K13B	20M30045	
B152	1	Valve, Ball, Pneumatic	Shutoff, Actuation 750 psig GN <sub>2</sub> , Operating 150 psig LOX	Parker Aircraft Co. PN F61C0017	20M30042	
B153	1	Nozzle Assembly	LOX fill		20M30202	
B154	1	Nipple, Quick-Disconnect	1/4 in., 750 psig GN <sub>2</sub>	E. B. Wiggins PN 6105R109A4	20M30390	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
B155	1	Valve, Ball, Pneumatic	Actuation 750 psig GN2 Operating 150 psig LOX	Parker Aircraft Co. PN F61C0017M1	20M30042	
B156	1	Nipple, Quick-Disconnect	1/4 in.	E. B. Wiggins PN 6005R78A4	20M30138	
B157	1	Nipple, Quick-Disconnect	1/4 in.	E. B. Wiggins PN 6005R78A4	20M30138	
B158	1	Valve, Needle, Three-way	Calibration	Benton Corp. PN 15600	60C27526	
B159	1	Switch, Pressure, Differential	Actuation $22.5 \pm .3$ psig	Servomechanisms Inc. PN 816105, Type TR2124	20M30144	9A21
B160	1	Nipple, Quick-Disconnect		E. B. Wiggins PN 6105R109A4	20M30390	
B161						
B162-1	1	Valve, Pneumatic	Vent and Relief Relieves @ 57 +5 -0 psig		20M30460	
B162-2	1	Valve, Pneumatic	Vent and Relief Relieves @ 57 +5 -0 psig		20M30460	
B163	1	Valve, Pneumatic	Actuation 750 psig GN2 Gate-type	North American Aviation PN 9512-48410-61	20M30122	
B164	8	Valve, Check		Precision Equipment Co. PN 126060-2	20M30046	
B165						

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
B166	1	Switch, Pressure	Actuates 65 psia		20M30186	11A57
B167	1	Switch, Pressure	Actuates 60 psia		20M30185	11A59
B168	1	Valve, Needle, Three-way	Calibration	Benton Corp. PN 17500	60C27547	
B169	2	Orifice-Union Assembly			20M30033	
B170	1	Valve, Butterfly	Nominal Flow-rate 33.6 lb/sec	Parker Aircraft Co. PN 561A0041	20M30407	
B171 through B214 are not functionally applicable to this system.						
B215	1	Valve, Solenoid	3-way, 2-position Actuation 750 psig GN2	Marotta Valve Corp. PN 218263	20M30128	11A55
B216	1	Valve, Solenoid	3-way, 2-position Actuation 750 psig GN2	Marotta Valve Corp. PN 218263	20M30128	9A17
B217 through B221 are not functionally applicable to this system.						
B222	1	Valve, Solenoid	3-way, 2-position Actuation 750 psig GN2	Marotta Valve Corp. PN 218263	20M30128	11A53
B223 through B384 are not functionally applicable to this system.						
B385	1	Nipple, Quick-Disconnect	1 in., He	E. B. Wiggins PN 6005R92A16	20M30165	

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
B386						
B387	1	Check Valve Assembly	1 in., He	James, Pond & Clark PN P220T-16BB(L)	20M30379	
		B388 through B449	are not functionally applicable to this system.			
B450	1	Nipple, Quick-Disconnect	1/2 in., He	E. B. Wiggins PN 6005R70A8	20M30141	
B451	8	Orifice	.102 dia, He		20M30199	
		B452 through E149	are not functionally applicable to this system.			
E150	1	Quick Disconnect Nipple Assembly		Douglas Aircraft PN 1A84828-1		
E151	1	Valve, Pneumatic	475 ± 25 psig He Actuation	B. H. Hadley PN 11084-11	407A15	
E152	1	Container, LOX	1263 ft <sup>3</sup> 45-48 psia	Douglas Aircraft PN 5863804-507		
E153	1	Valve, Pneumatic	No. 1 Vent and Relief Crack 50 psia Reseat 47 psia	Calmec Mfg Corp. PN 230-501	407A11	
E154	1	Valve, Pneumatic	No. 2 Vent and Relief Crack 50 psia Reseat 47 psia	Calmec Mfg. Corp. PN 230-501	407A12	
E155	1	Antivortex Screen Assembly	# 304 Wire Mesh	Douglas Aircraft PN 5851779-1		

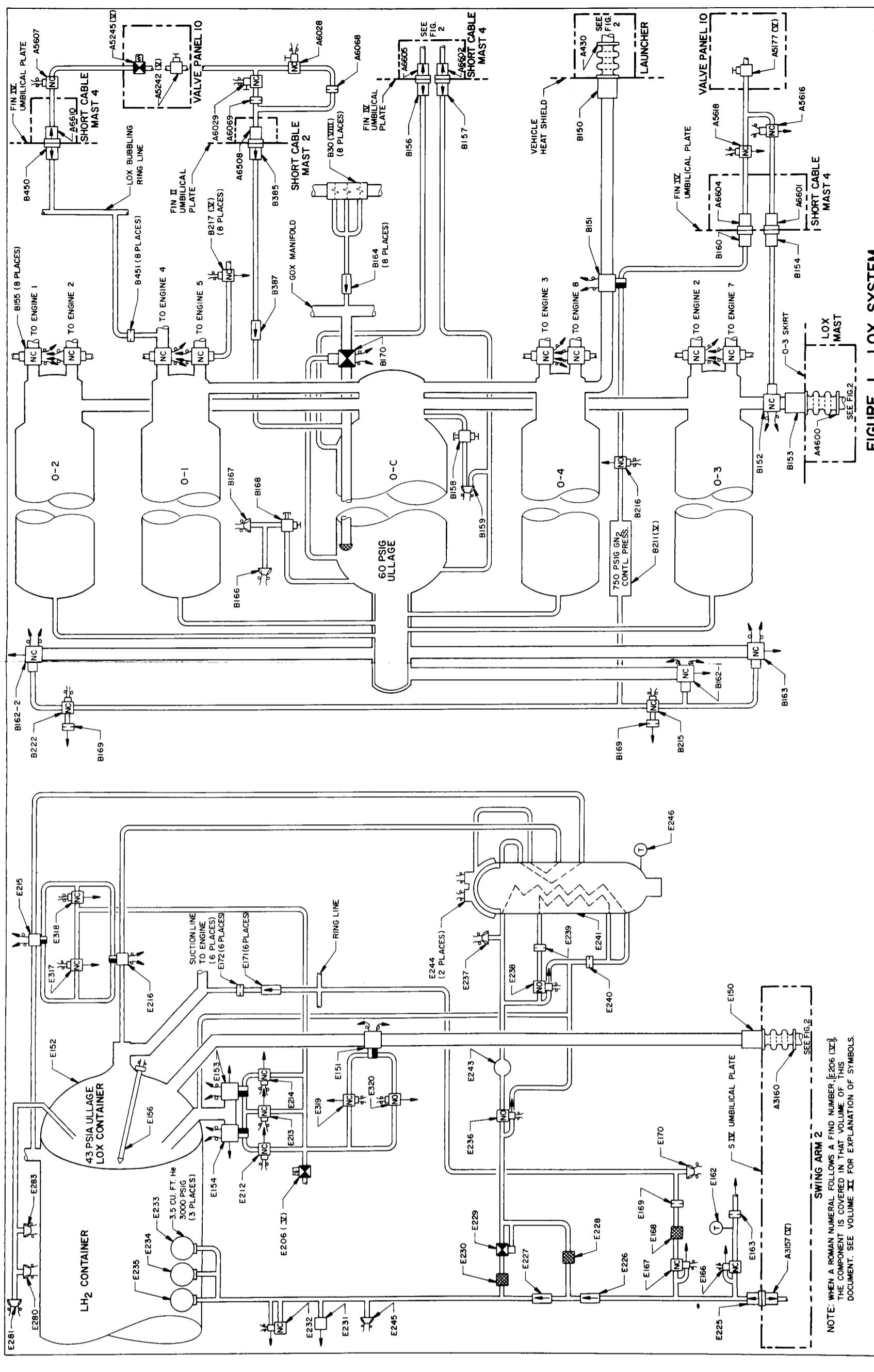
FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
E156	1	Sensor, LOX		Minneapolis Honeywell PN FG359B-1		408A1
E157	through E161	are not functionally applicable to this system.				
E162	1	Switch, Thermal	Actuates - 298 $\pm$ 15°F Deactuates - 258 $\pm$ 15°F	Douglas Aircraft PN 1A65853-1		407A23
E163	1	Orifice	.093 in., dia.	Douglas Aircraft PN S0268-C6-093		
E164						
E165						
E166	1	Valve, Solenoid		Douglas Aircraft PN 7851845-511		407L13
E167	1	Valve, Solenoid		Douglas Aircraft PN 7851845-511		407L14
E168	1	Filter	10 micron	Douglas Aircraft PN 7851840-1		
E169	1	Orifice	.031 in. dia.	Douglas Aircraft PN S0268-C6-031		
E170	1	Switch, Pressure	Pickup 320 $\pm$ 10 psia Dropout 115 $\pm$ 15 psia	Frebank Co. PN 4940-1		407S12
E171	6	Valve, Check		W. M. Lanagan Co. PN 90048		

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
E172	6	Orifice	.031 in. dia.	Douglas Aircraft PN S0268-C4-031		
		E173 through E211 are not functionally applicable to this system.				
E212	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 223544-1	407L9	
E213	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 223544-1	407L10	
E214	1	Valve, Solenoid	3-way, 2-position	Marotta Valve Corp. PN 223544-1	407L8	
E215	1	Valve, Pneumatic	475 ± 25 psig, He	Clary Dynamics PN 524122	407A8	
E216	1	Valve, Pneumatic	475 ± 25 psig, He	Clary Dynamics PN 524122	407A7	
		E217 through E224 are not functionally applicable to this system.				
E225	1	Coupling-Half, Quick-Disconnect	3000 ± 100 psig He	Douglas Aircraft PN 1A84439-1		
E226	1	Valve, Check		W. M. Lanagan Co. PN 90065		
E227	1	Valve, Check		W. M. Lanagan Co. PN 90065		
E228	1	Filter		Aircraft Porous Media Co., AC 4289-61		

FINDING NUMBER	NO. REQD	COMPONENT	REMARKS	VENDOR	DRAWING NUMBER	ELEC SYM
E229	1	Regulator, Pressure	Inlet 3000 psig He Outlet 250 psig He	B. H. Hadley PN 11089-3		
E230	1	Filter		Aircraft Porous Media Co., PN AC 4289-61		
E231	1	Valve, Relief		Sterer Engineering Co. PN 20500		
E232	1	Valve, Solenoid		Douglas Aircraft PN 7851845-511	40715	
E233	1	Sphere	3.5 Cu. Ft. @ 3000 psig He	Douglas Aircraft PN 7851834-501		
E234	1	Sphere	3.5 Cu. Ft. @ 3000 psig He	Douglas Aircraft PN 7851834-501		
E235	1	Sphere	3.5 Cu. Ft. @ 3000 psig He	Douglas Aircraft PN 7851834-501		
E236	1	Valve, Solenoid	Pilot-operated	Douglas Aircraft PN 7851845-509		
E237	1	Switch, Pressure	Pickup $320 \pm 10$ psia Dropout $115 \pm 15$ psia	Frebank Co. PN 4940-1	40716	
E238	1	Valve, Solenoid	Pilot-operated	Douglas Aircraft PN 7851845-509	40717	
E239	1	Orifice	0.250 in. dia.	Douglas Aircraft PN 4851838-C8-250		
E240	1	Orifice	0.375 in. dia.	Douglas Aircraft PN S4851838D12-375		







**FIGURE I.** LOX SYSTEM

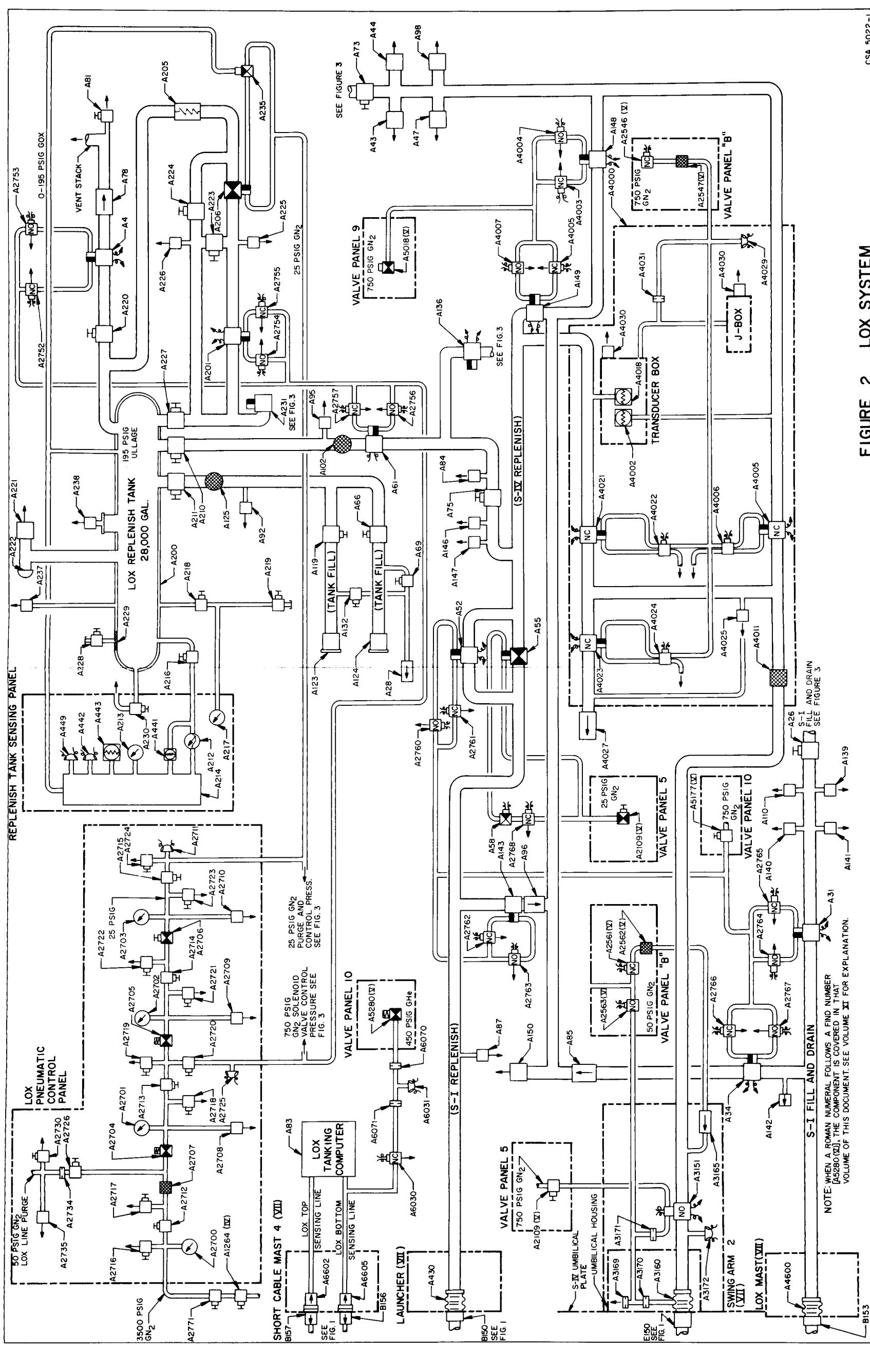


FIGURE 2 LOX SYSTEM

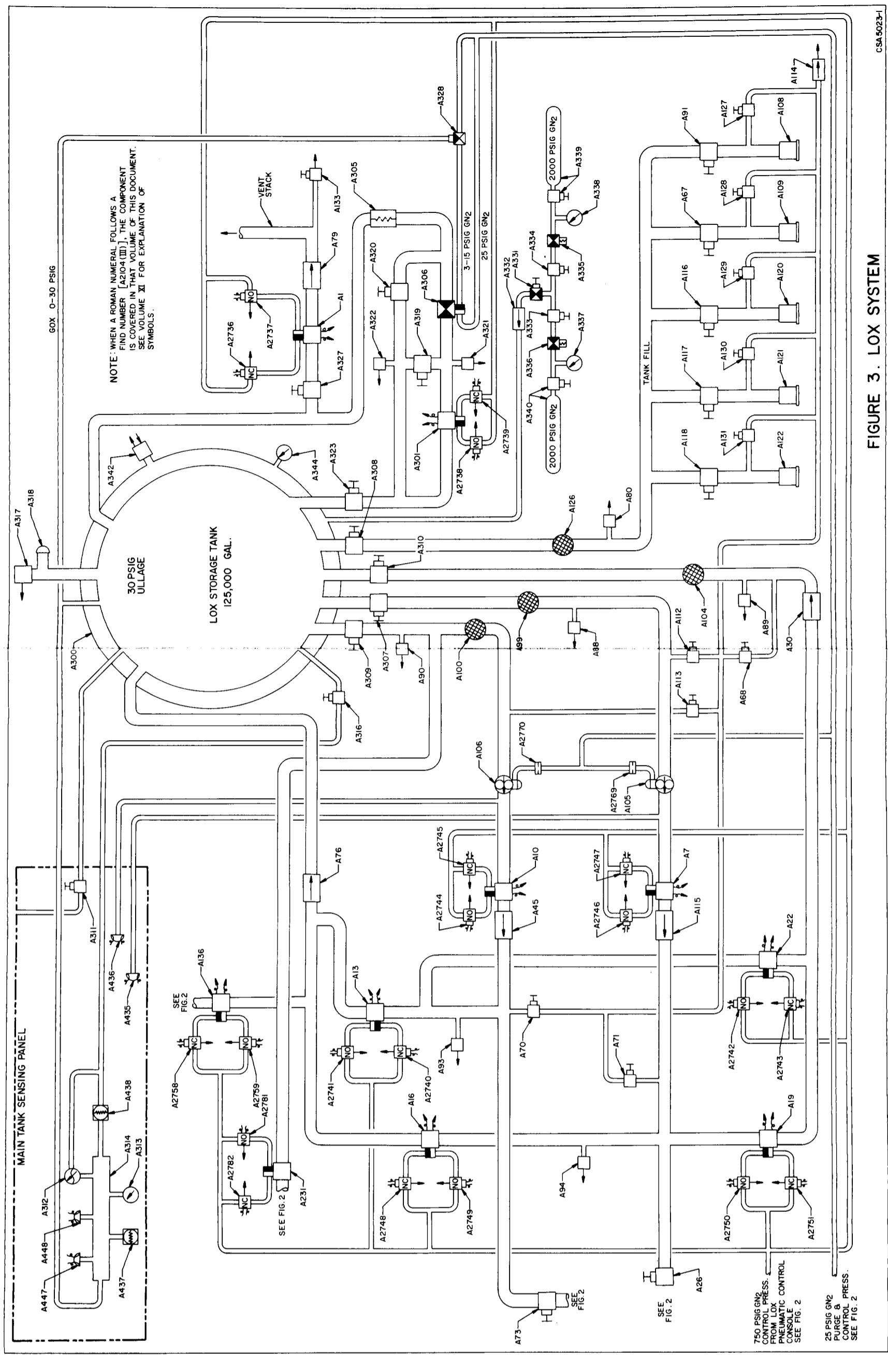


FIGURE 3. LOX SYSTEM

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